CLAIMS

What is claimed is:

1. A liquid crystal display, comprising:

a first substrate having an optically transmissive character;

a second substrate positioned adjacent to the first substrate and having a reflective character and an active area bordered by a perimeter seal area;

a plurality of spacers configured about the perimeter seal area of the second substrate, wherein the first substrate is separated from the second substrate by the plurality of spacers so as to form a cell gap; and

a liquid crystal material positioned in the cell gap between the first substrate and the second substrate.

2. The liquid crystal display of claim 1 further comprising:

means for communicating directly between the first substrate and the second substrate.

3. The liquid crystal display of claim 2 wherein the means for communicating is at least one cross-over.

4. The liquid crystal display of claim 3 further comprising:

a first alignment layer disposed on a bottom surface of the first substrate; and

a second alignment layer disposed on a top surface of the second substrate, wherein the top surface of the second substrate is complementary to the bottom surface of the first substrate and

wherein the at least one cross-over is pierced through the first alignment layer and the second alignment layer.

5. The liquid crystal display of claim 4 wherein the at least one cross-over contains nickel particles and first alignment layer and the second alignment layer contain polyimide.

6. The liquid crystal display of claim 1 further comprising

a conductive coating disposed without patterning on a bottom surface of the first substrate.

7. The liquid crystal display of claim 6 wherein the conductive coating is made of a transparent metal oxide.

8. The liquid crystal display of claim 7 wherein the transparent metal oxide is Indium Tin Oxide.

9. The liquid crystal display of claim 1, wherein the plurality of spacers are limited to the perimeter seal area.

10. The liquid crystal display of claim 9, wherein each of the plurality of spacers is a sphere having a diameter of approximately 2.1 microns.

11. The liquid crystal display of claim 10, further comprising a sealing material configured about a portion of the perimeter seal area, wherein the plurality of spacers are coated with the sealing material.

12. The liquid crystal display of claim 1, wherein the second substrate is a single crystal semiconductor substrate, the active area includes a circuit panel, the cell gap measures approximately 1.5-3.0 microns, and one end of the first substrate extends over a complementary end of the second substrate so as to expose an offset portion on a surface of the second substrate.

13. The liquid crystal display of claim 12 further comprising:

means for transmitting audible signals; and

means for converting sound waves into an electric current.

14. The liquid crystal display of claim 13, wherein the means for transmitting audible signals and the means for converting sound waves into an electric current is a single-chip radio disposed on the second substrate.

15. The liquid crystal display of claim 13, wherein the single-chip radio is coupled to a radio frequency filter and to a tank circuit.

16. A liquid crystal display assembly, comprising:

a first substrate having an optically transmissive character;

a second substrate having a reflective character, the second substrate positioned adjacent to the first substrate and having a plurality of active areas wherein each of the plurality of active areas are bordered by a perimeter seal area;

a plurality of spacers configured about each perimeter seal area of the second substrate, wherein the first substrate is separated from the second substrate by the plurality of spacers so as to form a plurality of gaps; and

a liquid crystal material positioned between the first substrate and the second substrate within each gap.

17. The liquid crystal display assembly of claim 16, the second substrate having a perimeter, the first substrate having a glass cover, the glass cover having a perimeter that substantially follows the perimeter of the second substrate.

18. The liquid crystal display assembly of claim 17 wherein the perimeter of the glass cover is circular and falls within an eight inch diameter.

19. The liquid crystal display assembly of claim 18 wherein the perimeter of the glass cover comprises at least one straight portion.

20. A method of making a liquid crystal display, comprising:

providing first substrate having an optically transmissive character;

providing a second substrate having a reflective character and an active area bordered by a perimeter seal area;

configuring a plurality of spacers about the perimeter seal area of the second substrate;

positioning the second substrate adjacent to the first substrate so that the second substrate is separated from the first substrate by the plurality of spacers so as to form a cell gap; and

positioning a liquid crystal material in the cell gap between the first substrate and the second substrate.

21. The method of claim 20 further comprising:

providing means for communicating directly between the first substrate and the second substrate.

22. The method of claim 21 wherein the means for communicating is at least one cross-over.

23. The method of claim 22 further comprising:

disposing a first alignment layer on a bottom surface of the first substrate;

disposing a second alignment layer on a top surface of the second substrate, wherein the top surface of the second substrate is complementary to the bottom surface of the first substrate; and

piercing the at least one cross-over through the first alignment layer and the second alignment layer.

24. The method of claim 20 further comprising:

disposing a conductive coating without patterning on a bottom surface of the first substrate.

25. The method of claim 20 further comprising:

restricting the plurality of spacers to the perimeter seal area, wherein the active area includes a circuit panel.

26. The method of claim 25, prior to configuring a plurality of spacers about the perimeter seal area of the second substrate, further comprising:

coating the plurality of spacers with a sealing material.

27. The method of claim 20 wherein positioning the second substrate adjacent to the first substrate comprises:

providing a mechanical press including a first plate and a second plate, the second plate having an inflatable bladder;

aligning the first substrate and the second substrate in the mechanical press between the first plate and the bladder of the second plate;

placing a shim plate between the bladder and one of the first substrate and the second substrate; and

inflating the bladder.

28. The method of claim 27, wherein the shim plate is placed between the bladder and the second substrate.

29. The method of claim 27, the first substrate having a first area and the second substrate having a second area smaller than the first area, wherein positioning the second substrate adjacent to the first substrate further comprises:

placing a shim between the first substrate and the shim plate.

30. The method of claim 27, wherein providing a mechanical press including a first plate and a second plate further comprises:

heating at least one of the first plate and the second plate.

31. The method of claim 27, prior to placing a shim plate between the bladder and one of the first substrate and the second substrate, further comprising:

obtaining a shim plate made of a flexible material.

32. The method of claim 20 wherein positioning the second substrate adjacent to the first substrate comprises:

providing a bag having an opening;

aligning the first substrate and the second substrate in the bag;

drawing a vacuum in the bag; and

curing the first substrate and the second substrate.

33. The method of claim 32 wherein drawing a vacuum in the bag comprises:

back filling the bag with a gas; and

evacuating the gas by drawing a vacuum in the bag.

34. A method of making a liquid crystal display, comprising:

providing a first substrate having an optically transmissive character;

providing a second substrate having a reflective character and an active area including a circuit panel and a perimeter seal area surrounding the active area;

providing a bag having an opening;

aligning the first substrate and the second substrate in the bag;

drawing a vacuum in the bag to position the second substrate adjacent to the first substrate, the second substrate separated from the first substrate to form a cell gap; and

curing the first substrate and the second substrate.

35. The method of claim 34, prior to providing a bag having an opening, further comprising:

providing a plurality of spacers configured about the perimeter seal area of the second substrate to form the cell gap.

36. The method of claim 35, further comprising:

restricting the plurality of spacers to the perimeter seal area of the second substrate.

37. The method of claim 35, prior to providing a plurality of spacers configured about the perimeter seal area of the second substrate, further comprising:

coating the plurality of spacers with a sealing material.

38. A method of making a liquid crystal display, comprising:

providing a wafer having a plurality of circuit devices, each circuit device including a circuit area and a perimeter seal area surrounding the circuit area;

providing an optically transmissive substrate;

coupling the wafer adjacent to the optically transmissive substrate to form a cell gap;

positioning a liquid crystal material in the cell gap between the wafer and the optically transmissive substrate; and

dividing the wafer into a plurality of display, each display including one of the plurality of circuit devices.

39. The method of claim 38, each circuit device including a perimeter seal area surrounding the circuit area, further comprising:

providing a plurality of spacers configured about the perimeter seal area of each circuit device to form the cell gap.

40. The method of claim 39, prior to providing a plurality of spacers, further comprising:

coating the plurality of spacers with a bonding material.

41. A method of making a display, comprising:

providing a first substrate having a plurality of circuit devices, each circuit device including a circuit area, each circuit device separated from each other circuit device by a scribe area;

providing an optically transmissive second substrate having a first surface and a second surface;

coupling the first substrate adjacent to the first surface of the second substrate to form a cell gap;

depositing an optical film over a portion of at least one of the first substrate and the second surface of the second substrate; and

dividing the first substrate in the scribe areas and the second substrate in at least one direction with an aligned relation to the scribe areas to create individual display.

42. The method of claim 41 wherein dividing the first substrate and the second substrate further comprises:

cutting the first substrate in the scribe areas to cut through a portion of the first substrate;

scribing the second substrate in a first direction of areas of the second surface with an aligned relation to scribe areas of the first substrate and in a second direction of areas of the second surface without an aligned relation to scribe areas of the first substrate; and

venting the second substrate.

43. The method of claim 41, a first surface of the first substrate having the plurality of circuit devices, further comprising:

cutting through a portion of a second surface of the first substrate in an aligned relation to the scribe areas.

44. The method of claim 43, the second substrate having a surface area larger than a surface area of the first substrate and prior to the step of cutting through a portion of the second surface of the first substrate, further comprising:

providing at least one alignment mark on the second surface of the second substrate to align the second substrate to the scribe areas on the first surface of the first substrate.

45. The method of claim 42, wherein the optically transmissive substrate is scribed by a laser process.

46. The method of claim 41, the step of dividing the second substrate further comprising:

removing the optical film from areas of the second surface in an aligned relation to the scribe areas adjacent each circuit device.

47. A method of making a display, comprising:

providing a first substrate having a plurality of circuit devices, each circuit device including a circuit area, each circuit device separated from each other circuit device by a scribe area;

providing an optically transmissive second substrate having a first surface and a second surface;

coupling the first substrate adjacent to the first surface of the second substrate and separated from the first surface of the second substrate to form a cell gap;

scribing an alignment mark in the area of the second surface without an aligned relation to the first substrate;

dicing the first substrate in the scribe areas to cut through a portion of the first substrate;

scribing the optically transmissive substrate in areas of the second surface in an aligned relation to scribe areas of the first substrate to form shallow cuts; and

venting the optically transmissive substrate.

48. The method of claim 47, further comprising:

positioning a liquid crystal material in the cell gap between the first substrate and the second substrate.

49. The method of claim 48, wherein positioning a liquid crystal material in the cell gap between the first substrate and the second substrate follows coupling the first substrate adjacent to the first surface of the second substrate.

50. The method of claim 47, after coupling the first substrate adjacent to the first surface of the second substrate, further comprising:

depositing an optical film over a portion of the second surface of the second substrate.

51. A method of making a display, comprising:

providing a first substrate having a perimeter and a plurality of circuit devices, each circuit device including a circuit area, each circuit device separated from each other circuit device by a scribe area;

providing an optically transmissive second substrate having a first surface and a second surface and having a perimeter that substantially follows the perimeter of the first substrate;

coupling the first substrate adjacent to the first surface of the second substrate to form a cell gap;

depositing an optical film over a portion of at least one of the first substrate and the second surface of the second substrate;

removing material from the optically transmissive second substrate in an X-direction to reveal a top exposed substrate and an X-surface substrate;

removing material from the optically transmissive second substrate in a Y-direction to reveal a side exposed substrate and a Y-surface substrate

removing material at the top exposed wafer in a direction that is parallel to the X-surface substrate to form an X-registration;

removing material at the side exposed wafer in a direction parallel to the Y-surface substrate to form a Y-registration;

drawing cuts into the first substrate using the relative registration provided by the X-registration and the Y-registration;

scribing the second substrate; and

venting the second substrate.

52. A method of placing liquid crystal material within an individual liquid crystal display device, comprising:

providing a chamber having a dropper containing liquid crystal material;

providing an individual liquid crystal display device having a perimeter seal area that defines a gap and a fill port that serves as an entrance to the gap;

arranging the display device within the chamber so that the gap faces the dropper;

drawing a vacuum in the chamber;

dispensing a drop of liquid crystal material from the dropper onto the gap;

introducing pressure into the chamber so that the liquid crystal drop is drawn into the gap.